

What is claimed is:

1. A channel state measurement apparatus for a receiver, comprising:
  - a direct channel state measurement unit for receiving complex symbol streams, for performing de-mapping on the complex symbol streams, for calculating an error signal based on the received complex symbol streams and de-mapped complex symbol streams, and for generating direct channel state information based on the calculated error signal;
  - an indirect channel state measurement unit for generating indirect channel state information based on a magnitude of a channel frequency response;
  - a co-channel interference detection unit for generating a channel state selection control signal based on the calculated error signal and magnitude of the channel frequency response; and
  - a selection unit for selectively outputting one of the direct channel state information and indirect channel state information, based on a logic state of the channel state selection control signal.
2. The apparatus of claim 1, wherein the direct channel state measurement unit comprises:
  - a first de-mapping and pilot insertion unit for inserting a given pilot into an I stream of the complex symbol streams, for performing de-mapping on the I stream, and for outputting the de-mapped I stream;
  - a first subtraction unit for subtracting the de-mapped I stream from the I stream to output a first subtraction result;
  - a first squaring unit for squaring the first subtraction result to output a first squaring result;
  - a second de-mapping and pilot insertion unit for inserting the given pilot into a Q stream of the complex symbol streams, for performing de-mapping on the Q stream, and for outputting the de-mapped Q stream;
  - a second subtraction unit for subtracting the de-mapped Q stream from the Q stream to output a second subtraction result;
  - a second squaring unit for squaring the second subtraction result to output a second squaring result;
  - a summation unit for summing the first squaring result and second

squaring result to output a summed value;

an averaging unit for averaging a summed value output from the summation unit during a current symbol duration and a summed value output from the summation unit during a previous symbol duration to output the error signal; and

a non-uniform quantizing unit for quantizing the error signal by inverting the error signal using a non-uniform transfer function to output the direct channel state information.

3. The apparatus of claim 1, wherein the indirect channel state information is a signal obtained by quantizing the magnitude of the channel frequency response with a uniform transfer function.

4. The apparatus of claim 1, wherein the co-channel interference detection unit comprises:

a third squaring unit for squaring the magnitude of the channel frequency response to output a third squaring result;

a multiplication unit for multiplying the third squaring results and the error signal to output a multiplication result signal;

a FIR filter for integrating given carriers included in the multiplication result signal based on non-recursive filtering to provide an integrated signal;

a third subtraction unit for subtracting first coefficient information from the integrated signal to output a third subtraction result;

a negative value discarding unit for discarding a negative-valued third subtraction result and outputting a positive-valued third subtraction result as an output signal;

an accumulating unit for accumulating the output signal during one symbol duration to output an accumulation result;

a symbol averaging filter for averaging an accumulation result output from the accumulating unit during a current symbol duration with an accumulation result output during a previous symbol duration to output an averaged signal;

a first comparator for comparing the averaged signal with second coefficient information to output first comparison information;

a second comparator for comparing the averaged signal with third coefficient information to output second comparison information; and  
a logic circuit for outputting the channel state selection control signal based on a logic state of one of the first comparison information and second comparison information.

5. The apparatus of claim 4, wherein the logic circuit outputs the channel state selection control signal:

at a second logic state, if the first comparison information is at the second logic state, or  
at a first logic state, if the second comparison information is at the second logic state, or  
at its previous logic state, if one of the first comparison information and second comparison information is at the first logic state.

6. The apparatus of claim 1, wherein the co-channel interference detection unit comprises:

a third squaring unit for squaring the magnitude of the channel frequency response to output a third squaring result;

a first multiplication unit for multiplying the third squaring unit and the error signal to output a first multiplication result;

a first switching circuit for enabling output of the first multiplication result based on a logic state of interference affected carrier information;

a first accumulating unit for accumulating the first multiplication result, if received from the first switching unit, during one symbol duration to output a first accumulation result;

a second switching circuit for enabling output of the first multiplication result based on a logic state of non interference affected carrier information;

a second accumulating unit for accumulating the first multiplication result, if received from the second switching unit, during one symbol duration to output a second accumulation result;

a second multiplication unit for multiplying the second accumulation result and a first coefficient information together to output a second multiplication result;

a third subtraction unit for subtracting the second multiplication result from the first accumulated result to output a third subtraction result;

a symbol averaging filter for averaging an third subtraction result output from the third subtraction unit during a current symbol duration with a third subtraction result output during a previous symbol duration to output an averaged signal;

a first comparator for comparing the averaged signal with second coefficient information to output first comparison information;

a second comparator for comparing the averaged signal with third coefficient information to output second comparison information; and

a logic circuit for outputting the channel state selection control signal based on a logic state of one of the first comparison information and second comparison information.

7. The apparatus of claim 6, wherein the logic circuit outputs the channel state selection control signal:

at a second logic state, if the first comparison information is at the second logic state, or

at a first logic state, if the second comparison information is at the second logic state, or

at its previous logic state, if one of the first comparison information and second comparison information is at the first logic state.

8. The apparatus of claim 6, wherein

the first switching unit only outputs the first multiplication result to the first accumulating unit if the logic state of the interference affected carrier information is in a second logic state; and

the second switching unit only outputs the first multiplication result to the second accumulating unit if the logic state of the non interference affected carrier information is in a second logic state.

9. The apparatus of claim 1, wherein the receiver is a digital video broadcasting-terrestrial DVB-T receiver.

10. A method of providing channel state information in a receiver, comprising:

- (a) generating direct channel state information based on a calculated error signal;
- (b) generating indirect channel state information based on a magnitude of a channel frequency response;
- (c) generating a channel state selection control signal based on the calculated error signal and magnitude of the channel frequency response; and
- (d) selectively outputting one of the direct channel state information and indirect channel state information based on a logic state of the channel state selection control signal.

11. The method of claim 10, wherein step (a) comprises:

- (a1) inserting a given pilot into an I stream of a plurality of received complex symbol streams;
- (a2) de-mapping the I stream to output a de-mapped I stream;
- (a3) subtracting the de-mapped I stream from the I stream to output a first subtraction result;
- (a4) squaring the first subtraction result to output a first squaring result;
- (a5) inserting the given pilot into a Q stream of the complex symbol streams;
- (a6) de-mapping the Q stream to output a de-mapped Q stream;
- (a7) subtracting the de-mapped Q stream from the Q stream to output a second subtraction result;
- (a8) squaring the second subtraction result to output a second squaring result;
- (a9) summing the first squaring result and the second squaring result to output a sum;
- (a10) averaging the sum output during a current symbol duration and the sum output during a previous symbol duration to generate a calculated error signal; and
- (a11) quantizing the error signal by inverting the error signal using a non-uniform transfer function to generate the direct channel state information.

12. The method of claim 10, wherein the indirect channel state information is a

signal obtained by quantizing the magnitude of the channel frequency response with a uniform transfer function.

13. The method of claim 10, wherein step (c) comprises:

(c1) squaring the magnitude of the channel frequency response to output a third squaring result;

(c2) multiplying the third squaring result and the error signal together to output a multiplication result;

(c3) integrating given carriers included in the multiplication result using non-recursive filtering to output an integration result;

(c4) subtracting first coefficient information from the integration result to output a third subtraction result;

(c5) discarding a negative-valued third subtraction result, else outputting a positive-valued third subtraction result as an output signal;

(c6) accumulating the output signal during one symbol duration to generate an accumulation result;

(c7) averaging the accumulation result for a current symbol duration and an accumulation result during a previous symbol duration to output an averaged signal;

(c8) comparing the averaged signal with second coefficient information, to generate first comparison information;

(c9) comparing the averaged signal with third coefficient information to generate second comparison information; and

(c10) generating the channel state selection control signal based on a logic state of one of the first comparison information and second comparison information.

14. The method of claim 13, wherein step (c10) includes:

(c101) generating the channel state selection control signal at a second logic state, if the first comparison information is at the second logic state, or

(c102) generating the channel state selection control signal at a first logic state, if the second comparison information is at the second logic state, or

(c103) generating the channel state selection control signal at its previous logic state, if one of the first comparison information and second

comparison information is at the first logic state.

15. The method of claim 10, wherein step (c) comprises:

(c1) squaring the magnitude of the channel frequency response to output a third squaring result;

(c2) multiplying the third squaring result with the error signal to output a first multiplication result;

(c3) outputting the first multiplication result, if an interference affected carrier information is in a given logic state;

(c4) accumulating the first multiplication result corresponding to the interference affected carrier information during one symbol duration to output a first accumulation result;

(c5) outputting the first multiplication result, if a non interference affected carrier information is in a given logic state;

(c6) accumulating the first multiplication result corresponding to the non-interference affected carrier information during one symbol duration to output a second accumulation result;

(c7) multiplying the second accumulation result and first coefficient information to output a second multiplication result;

(c8) subtracting the second multiplication result from the first accumulation result to output a third subtraction result;

(c9) averaging the third subtraction result for a current symbol duration and the third subtraction result for a previous symbol duration to output an averaged signal;

(c10) comparing the averaged signal with second coefficient information, to generate first comparison information;

(c11) comparing the averaged signal with third coefficient information to generate second comparison information; and

(c12) generating the channel state selection control signal based on a logic state of one of the first comparison information and second comparison information.

16. The method of claim 15, wherein step (c12) includes:

(c121) generating the channel state selection control signal at a second

logic state, if the first comparison information is at the second logic state, or  
(c122) generating the channel state selection control signal at a first logic state, if the second comparison information is at the second logic state, or  
(c123) generating the channel state selection control signal at its previous logic state, if one of the first comparison information and second comparison information is at the first logic state.

17. In a channel state measurement apparatus of a receiver, a co-channel interference detector for providing a selection signal to selectively output one of direct channel state information determined from a calculated error signal and indirect channel state information determined from a channel frequency response, comprising:

- a multiplier for multiplying a squared value of the magnitude of the channel frequency response and the error signal to output a multiplication result;

- a filter for integrating the multiplication result to output an integration result;

- a subtractor for subtracting given coefficient information from the integration result to output a subtraction result;

- a discarding unit for discarding a negative-valued subtraction result, else outputting a positive-valued subtraction result as an output signal;

- an accumulator for accumulating the output signal during one symbol duration to generate an accumulation result;

- an averager for averaging the accumulation result for a current duration and an accumulation result during a previous duration to output an averaged signal to be used for generating first and second comparison information; and

- a logic unit for generating the selection control signal based on a logic state of one of the first comparison information and second comparison information.

18. The detector of claim 17, wherein the logic unit generates the selection control signal:

- at a high logic state, if the first comparison information is at the high logic



state, or

at a low logic state, if the second comparison information is at the high logic state, or

at its previous logic state, if one of the first comparison information and second comparison information is at the low logic state.

19. In a channel state measurement apparatus of a receiver, a co-channel interference detector for providing a selection signal to selectively output one of direct channel state information determined from a calculated error signal and indirect channel state information determined from a channel frequency response, comprising:

a first multiplier for multiplying a square of the magnitude of the channel frequency response with the error signal to output a first multiplication result;

a first switching circuit for outputting the first multiplication result, if an interference affected carrier information is in a given logic state;

a first accumulator for accumulating the first multiplication result during a given duration to output a first accumulation result;

a second switching circuit for outputting the first multiplication result, if a non interference affected carrier information is in a given logic state;

a second accumulator for accumulating the first multiplication result during a given duration to output a second accumulation result;

a second multiplier the second accumulation result and a given coefficient to output a second multiplication result;

a subtractor for subtracting the second multiplication result from the first accumulation result to output a subtraction result;

an averager for averaging the subtraction result for a current duration and a subtraction result during a previous duration to output an averaged signal to be used for generating first and second comparison information; and

a logic unit for generating the selection control signal based on a logic state of one of the first comparison information and second comparison information.

20. The detector of claim 19, wherein the logic unit generates the selection control signal:

at a high logic state, if the first comparison information is at the high logic state, or

at a low logic state, if the second comparison information is at the high logic state, or

at its previous logic state, if one of the first comparison information and second comparison information is at the low logic state.

21. A channel state measurement apparatus for a receiver that provides channel state information in accordance with the method of claim 10.

22. An apparatus for providing channel state information in a receiver in accordance with the method of claim 10.